Seventy-five presents were announced as having been received since the last meeting, including, amongst others :—

Harvard College Observatory Circular, No. 28 ; Photographic Spectrum of the Aurora, presented by the Observatory ; T. R. Dallmeyer, A simple guide to the choice of a photographic lens, presented by the author ; Two photographs of the total solar eclipse of 1898 January 22, taken by the Lick Observatory Expedition (lantern slides), presented by the Lick Observatory.

Vanadium in the Spectrum (C to D) of Sun-spots. By the Rev. A. L. Cortie, S.J.

In a former paper, entitled "Observations of the Spectra of Sun-spots in the region B – D" (*Memoirs R.A.S.* vol. l. p. 51), I called attention to a line near w.l. 6243·5, which was only just visible in the ordinary solar spectrum, but was very greatly widened when it crossed a spot. Since the publication of this paper my observations of the spot-spectra have been somewhat desultory, but in those which I have secured this line has been always most marked, being one of several faint lines in this region which are permanent and characteristic of the spectra of all spots. That this judgment is unbiassed is evidenced by the fact that, after a long break in the observations, when the region had become less familiar to me, and I had frequently to consult Mr. Higgs's beautiful maps while observing, the same line always claimed attention. The publication of Professor Rowland's "Preliminary Table of Solar Spectrum Wave-lengths" in the *Astrophysical Journal* has enabled me to fix the widening as almost certainly due to the very faint Vanadium line at 6243·055. The line is invisible in the ordinary spectrum with the Browning 12-prism spectroscope, but it can be seen in the second order of the grating spectroscope, and on 1891 September 7 over a spot, when it was clearly separated from the adjoining line at 6243·32, it was very much widened. Hence I conclude that the remarkable widening of the line, seen only across spots with the prism spectroscope in this position, is due to the Vanadium line. Moreover, its sympathy with the widening of other lines due to this metal is a further proof of its identity. Among such is a faint line at 6039·953 which is also much widened in all sun-spots. This has led me to study the behaviour of all the Vanadium lines catalogued in Professor Rowland's lists between C and D in the spectrum of sun-spots. The results are collected in the following table :—

No.	Rowland Wave-length.	Inten-sity.	Thalèn Spark.	Inten-sity.	Relative Mean Widening.	Remarks.
1	6039·95	0	6040·3	10	15	Always widened.
2	6081·67	0	6081·3	4	5	
3	...	...	6090·3	10	...	? 6090·43 Fe.
4	6111·87	0	6110·7	4	7	Sometimes with Ni 6111·29.
5	6119·74	1	6120·2	10	5	Sometimes with Ni 6119·97.
6	6135·58	00	6135·6	4	10	Very near Cr line 6135·99.
7	6150·36	0	...	...	9	
8	6170·42	0000	...	...	...	Not seen.
9	6199·40	0	...	...	15	Always widened.
10	6214·08	000	...	...	...	Not seen.
11	6224·72	000	...	...	...	Not seen.
12	6230·94	8	...	...	5	V and Fe.
13	6243·06	000	6241·8	6	40	Always very much widened.
14	6252·05	00	...	...	10	
15	6258·57	000	...	...	9	With Ti line 6258·32.
16	6261·50	0000	...	...	9	With Ti line 6261·32.
17	6269·08	000	...	...	30	From 4 observations only.
18	6285·38	00	...	...	...	Observed once.
19	6293·03	000	...	...	...	With O line 6293·17. Widened once.
20	6296·58	0000	...	...	...	Not seen.

The intensities of the solar lines in the third column are taken from Rowland's lists, in which a line of intensity 1 is one that is just visible on his Map of the Solar Spectrum, while intensities 0 to 0000 indicate increasing degrees of faintness. On this scale the lines C, D_2, and D_1 are of intensity 40, 30, and 20 respectively. In the fourth column are given the corrected wave-lengths of the lines of the metal observed in the spark by Thalèn, taken from Dr. Watts's "Index of Spectra," and in the next column their intensities, on a scale 1 to 10. The line 6090·3, which is one of the strongest in the spark according to Thalèn, seemingly does not appear among the solar lines. There is an iron line at 6090·43. In the fifth column is given the relative mean widening of the lines, which is an estimation of their approximate order in the spot spectrum. The want of correspondence with the normal intensities of the lines is apparent. The numbers have been obtained by taking means of all the observations of the widenings of the lines, reckoned in terms of the normal width of the lines in the ordinary spectrum and multiplying the results by 10. Thus 15 means that the line is, on an average, one and a half times as wide again in a spot as in the ordinary spectrum.

All the lines in the list are, with the one exception of a line coincident with an iron line, faint or very faint lines. Three of the faintest of all have not been observed, and five others cannot generally, with the dispersion employed, be separated from lines due to Ti, Ni, and O, which adjoin them. But the lines numbered 1, 9, and 13 are always widened in both maximum and minimum period spots. The line numbered 9 has near it two lines of the same intensity in the ordinary spectrum at positions 6194·63 and 6195·67. In observing these three lines over spots, although out of the spot they are of the same intensity, yet in the spot the Vanadium line is greatly widened, while the two others are unaffected. Such was the case, to give instances, on 1894 November 30 and December 12, and on 1896 November 6, when, at a time when the light did not allow of the lines being seen in the ordinary spectrum, the Vanadium line alone stood out where it crossed the spot, and later on, when the seeing improved, the Vanadium line was alone widened in the spot, the companion lines remaining unwidened. This is a case in which, of lines of the same intensity and near to one another, one is affected in spots and others are not, thus proving that the phenomenon observed is objective, and not merely optical and subjective. To take another example. At 6306·02 and 6306·78 are two lines of exactly the same intensity, according to Rowland and Thollon. The former of these two is both constantly and greatly widened in sun-spots, the latter never. Both these lines are due to atmospheric oxygen, yet in Thollon's map the line widened in sun-spots is, curiously enough, indicated as a solar line. Unless the widening of 6306·02 is due to some very faint solar lines on either side of its position, which with the dispersion employed would be coincident with it, the widening of this oxygen line would indicate the presence of the gas in sun-spots. Moreover, No. 19 in the list of Vanadium lines, which is a very faint line, is not two-tenths of a Xth metre removed from another oxygen line. The line at this wave-length was widened over a spot on 1896 November 8. If the oxygen line was unaffected, then the widening must be attributed to the very faint Vanadium line adjoining it. Similar remarks apply to the five lines in the above list which are close to Ti, Ni, and Cr lines. Indeed, in observations of this sort, in regions where the lines are closely packed together, unless a very high dispersion be employed, it is extremely easy to attribute the widening to lines of some particular metal, when in reality it belongs to some faint line which, with the dispersion employed, is coincident with a neighbouring line.

With regard to the presence of Vanadium in sun-spots, as indicated by the widening of these faint lines, it is noteworthy that its combining weight, 51·3, is very close to that of titanium, iron, nickel, and other elements about this atomic weight, which also are marked constituents of sun-spots. Its behaviour is very like that of the faint lines of titanium. This suggests that the

level of sun-spots is possibly the level of the faint lines of such metals as have an atomic weight about 50. To the objection that the lines of metals like calcium and sodium and the lines of hydrogen are also present, the answer seems to be that such elements are not confined to sun-spots, but extend to a great height in the solar atmosphere. Moreover, broad lines, like H and K and the C line, are generally reversed in the region about sun-spots, and the D lines frequently so. Two Vanadium lines in the region under discussion occur in Professor Young's list of chromospheric lines, but one of these is the close double due to Fe and V, which is one of the least widened of all the lines in sun-spots, No. 12 in the table, and is also the most intense of all the lines of the list in the ordinary spectrum; and the other, 6216·5, is not attributed to Vanadium in Rowland's Table. This line, however, is sometimes much widened in sun-spots; but, being of intensity 1, though a faint line, it would be one of the strongest lines of the list, if it is really a Vanadium line.

Stonyhurst College Observatory:
1898 *May* 7.

Notes on the Zodiacal Light. By William Anderson.

Mr. E. W. Maunder's note on the Zodiacal Light in the *Monthly Notices* for March has been of much interest to me, for since I first came to Madeira in the winter of 1895-96 I have given more or less attention to it, so far as delicate health and the difficulty of obtaining a clear western horizon admitted, and have arrived at conclusions somewhat different from his. Situated as I am, it has been impossible for me to examine directly either the results or conclusions of other observers, and this must be my apology if the results presented in this paper do not contain anything new. I had intended not to publish my conclusions until I had arrived at something more definite, but there are one or two points in Mr. Maunder's paper to which I wish to refer, besides which I have arrived at the conclusion that the mystery which surrounds the Zodiacal Light will never be cleared up until systematic observations are simultaneously undertaken at a number of different stations both in the northern and southern hemispheres. I have shown in the *English Mechanic* of 1896 July 17 that the variation in the appearance of the light from night to night is largely, if not entirely, due to atmospheric causes; and, as I shall endeavour to show presently, it is necessary to have simultaneous observations from several stations in both hemispheres before we can decide whether the appearances presented by the light are due to a deviation of its plane from that of the ecliptic, or solely to atmospheric absorption.